PROPOSED
TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Dissolved Oxygen & Nutrients

In

Stevenson Creek
(WBID 1567)

July 2013

EPA United States Environmental Protection Agency

Region 4 serving the southeast

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SUMMARY SHEET FOR WBID 1567

Total Maximum Daily Load (TMDL)

2009 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1567	Stevenson Creek	Class III Marine	Springs Coast	03100207	Pinellas	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen and Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)
	Wastewater (lbs/year)	NPDES Stormwater (percent reduction)			
$CBOD_5$	76,157[a]	85	9,314	Implicit	85,471
TN	33,509[a]	85	6,406	Implicit	39,915

Endangered Species Present (Yes or Blank): Yes

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Both

NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permittee(s)	County	Permit Type
. FL0021857	City of Clearwater-Marshall Street Advanced	Pinellas	NPDES

	Wastewater Treatment Plant (AWWTP)		
FLS000005	Pinellas County in conjunction with the Florida Department of Transportation (FDOT) District 7,	Pinellas	Phase I MS4

EPA would like to acknowledge that the contents of this report and the total maximum daily load (TMDL) contained herein were developed by the Florida Department of Environmental Protection (FDEP). Many of the text and figures may not read as though EPA is the primary author for this reason, but EPA is officially proposing the TMDL for dissolved oxygen and nutrients for Stevenson Creek (WBID 1567) and is soliciting comment. EPA is proposing this TMDL in order to meet consent decree requirements pursuant to the Consent Decree entered in the case of Florida Wildlife Federation, et al. v. Carol Browner, et al., Case No. 98-356-CIV-Stafford. EPA will accept comments on this proposed TMDL for 30 days in accordance with the public notice issued on June 26, 2013. Should EPA be unable to approve a TMDL established by FDEP for the 303(d) listed impairment addressed by this report, EPA will establish this TMDL in lieu of FDEP, after full review of public comments.

1.0 INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDLs) for nutrients and dissolved oxygen for the tidal portion of Stevenson Creek, which is located in the Anclote River/Coastal Pinellas County Planning Unit, which is part of the larger Springs Coast Group 5 Basin. The water segment was verified as impaired for dissolved oxygen and nutrients, and the waterbody was included on the Verified List of impaired waters for the Springs Coast Basin that was adopted by Secretarial Order in December 2007.

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality. The TMDLs establish the allowable loadings to the tidal segment of Stevenson Creek that would restore the waterbody so that it meets its applicable water quality criterion for dissolved oxygen and nutrients.

1.2 Identification of Waterbody

The Stevenson Creek watershed encompasses 9.8 square miles (6,288 acres) in west central Pinellas County **(Figure 1)**. The watershed area spans across several jurisdictions including the City of Clearwater (4,057 acres or 65 percent), City of Dunedin (1,287 acres or 20 percent), unincorporated parts of Pinellas County (859 acres or 14 percent), and the City of Largo (83 acres or 1 percent). Land uses within the basin are predominantly medium and high density residential, commercial, and open space. Further discussion of the land uses can be found in Chapter 4 of this report. Approximately 90 percent of the watershed is urbanized, with a significant portion of the development occurring prior to the implementation of regulatory requirements for floodplain preservation, environmental protection, stormwater treatment, and peak runoff attenuation. Several developments were constructed within the creek's floodplain and have experienced severe flooding. In addition, the creek and its tributaries experience moderate to severe erosion problems due to steep embankments, improper maintenance, highly erodible soils, and inadequate right-of-way.

For assessment purposes, the Department (FDEP) divided the Springs Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. **Figure 1** shows the location of the three water segments (WBIDs 1567, 1567B,and 1567C) that comprise the Stevenson Creek watershed. The Stevenson Creek tidal segment is assigned the WBID number 1567. The tidal segment receives drainage from the free flowing freshwater segment of Stevenson Creek designated as WBID 1567C, as well as two freshwater tributaries; Spring Branch (WBID 1567B) and Hammond Branch, a smaller tributary that is part of WBID 1567. The tidal segment is approximately 1.6 miles long and empties directly into Clearwater Harbor. The water quality monitoring locations and major roads in the vicinity of the tidal creek are displayed in **Figure 2.**

Additional information about the region's hydrology and geology are available in the Basin Status Report for the Springs Coast Basin (Florida Department of Environmental Protection [Department], 2006).

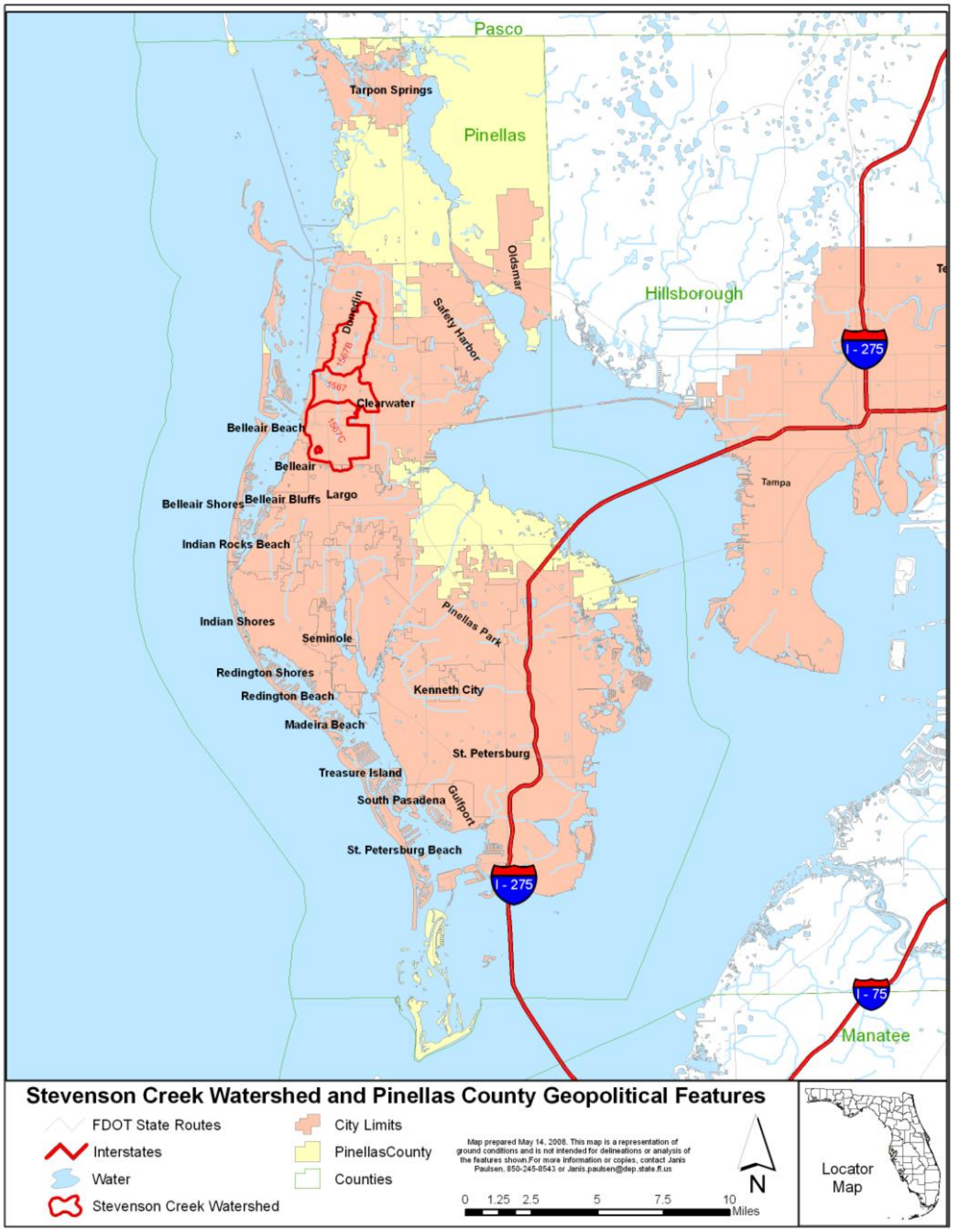

Figure 1 Location of the Stevenson Creek Watershed (WBIDs 1567, 1567B, and 1567C) and Major Geopolitical Features in Pinellas County.

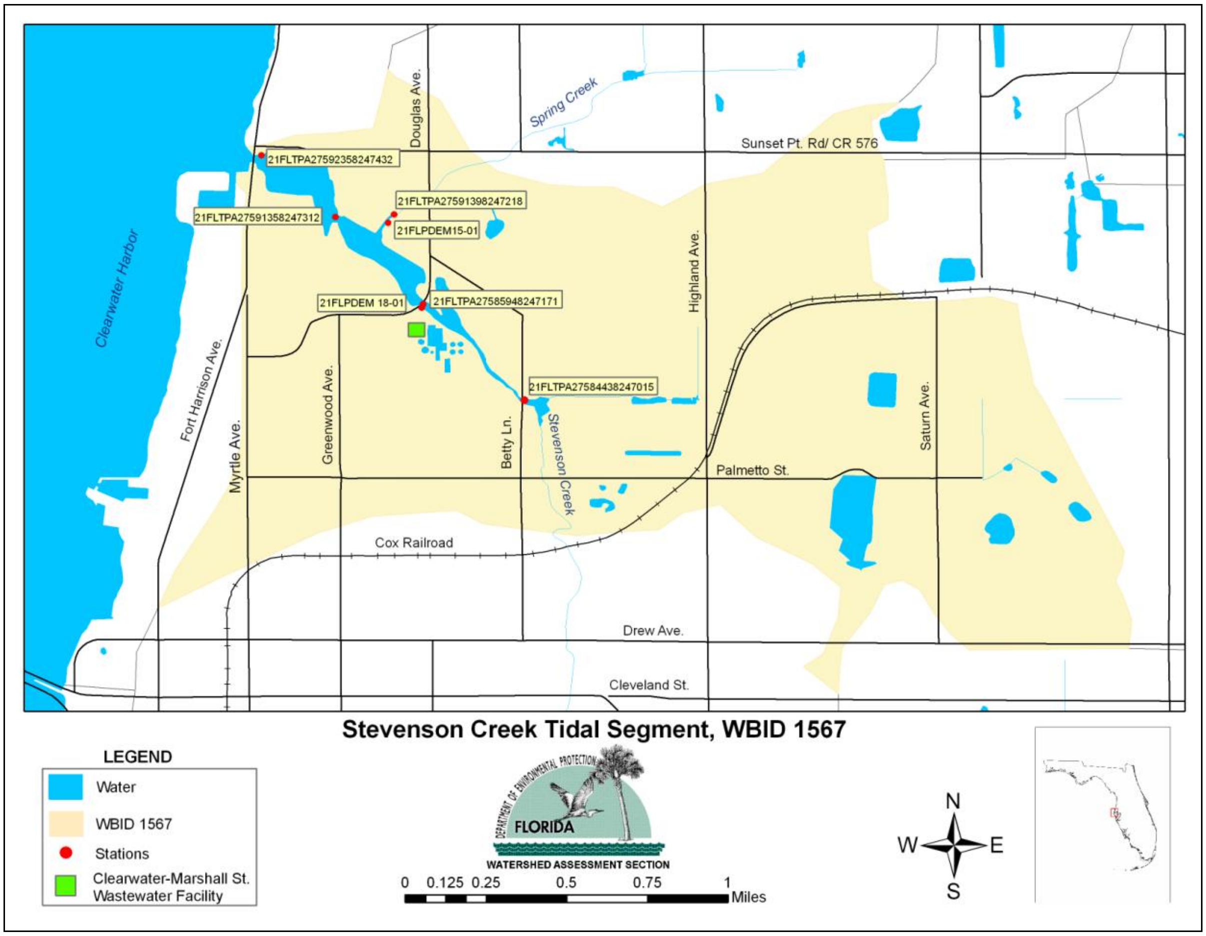

Figure 2 Monitoring Locations in the Stevenson Creek Tidal Segment, WBID 1567.

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA, Chapter 99-223, Laws of Florida); as amended.

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

This TMDL Report will be followed by the development and implementation of a restoration plan to reduce the amount of pollutants that caused the verified impairment of the Stevenson Creek tidal segment. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for the impaired waterbody.

2.0 DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U. S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant identified as causing the impairment of the listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 22 waterbodies in the Springs Coast Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001, which was amended in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Stevenson Creek tidal segment and verified the impairment for dissolved oxygen and nutrients (Table 1). Table 2 summarizes the dissolved oxygen (DO) data collected during the verification period (January 1, 1999–June 30, 2006). The WBID was verified as impaired for dissolved oxygen because more than 10 percent of the values were below the Class III marine criterion of 4 milligrams/liter (mg/L) over the course of the verified period. In performing estuary nutrient evaluations following the IWR methodology, annual average chlorophyll a values serve as the primary measurement for assessing nutrient impairment. Chlorophyll a is typically used as the primary indicator of nutrient enrichment because its concentrations are a good measure of the biomass of phytoplankton (the microscopic algae suspended in the water column) that utilize nutrients for growth. During the verified period, the annual average chlorophyll a values for the tidal segment (WBID 1567) were above the estuary threshold of 11 micrograms per liter (μg/L), averaging between 16.1 μg/L and 59.4 μg/L (Table 3 and Figure 3). According to the IWR, if the annual mean chlorophyll a for any one year is over the chlorophyll a threshold, the water is verified as impaired for nutrients.

The sources of data for the IWR assessment came from stations sampled by the Pinellas County Department of Environmental Management (21FLPDEM…) and the Florida DEP Southwest District (21FLTPA…). Sampling conducted by Pinellas County at stations, 21FLPDEMAMB 15-1 AND 21FLPDEMAMB 18-1, comprised the majority of the data. The DEP also collected data from the following stations; 21FLTPA27584438247015, 21FLTPA585948247171, 21FLTPA27591358247312, 21FLTPA27591398247218, and 21FLTPA27592358247432. Figure 1.2 shows the locations of these sampling sites. Figure 2.1 displays the dissolved oxygen data collected from 1999 through 2006 for each of these stations, while Figure 2.2 shows the chlorophyll a data from the same period. The individual water quality measurements used in this analysis are available in the IWR database, and are available upon request.

Monitoring results collected after 2006 were also evaluated and the results show that water quality in the tidal segment does not exhibit a trend over time and has remained fairly constant since the beginning of the Cycle 1 verification period. Water quality results of relevant variables, contained in the IWR Run 44 Database, that were collected from 1999 to the present are displayed in the graphs in Appendix C.

Table 1 Verified Impairment in the Stevenson Creek Tidal Segment, WBID 1567

Parameter Causing Impairment	Priority for TMDL Development	Projected Year For TMDL Development
Dissolved Oxygen	High	2007
Nutrients	High	2007

Table 2 Summary of Dissolved Oxygen Data for the Stevenson Creek Tidal Segment, WBID 1567 (1999–2004)

Number of Samples	Minimum (mg/L)	Mean (mg/L)	Median (mg/L)	Maximum (mg/L)	Number of Exceedances
121	0.25	3.35	3.14	20.03	77

Table 3 Summary of Chlorophyll a Data for the Stevenson Creek Tidal Segment, WBID 1567 (1999–2004).

Year	Annual Mean Chlorophyll a (µg/L)
1999	16.08
2000	32.74
2001	59.37
2002	24.75
2004	42.81

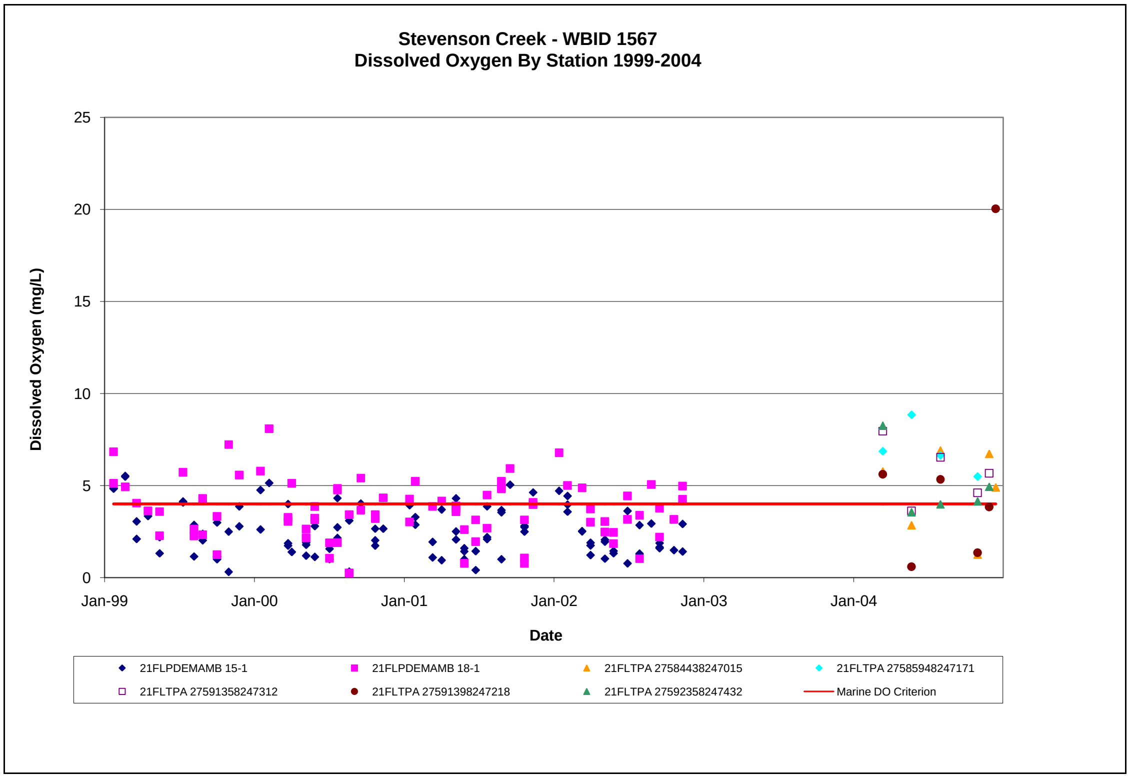

Figure 3 Dissolved Oxygen Measurements in the Stevenson Creek Tidal Segment, WBID 1567, During the Verified Period

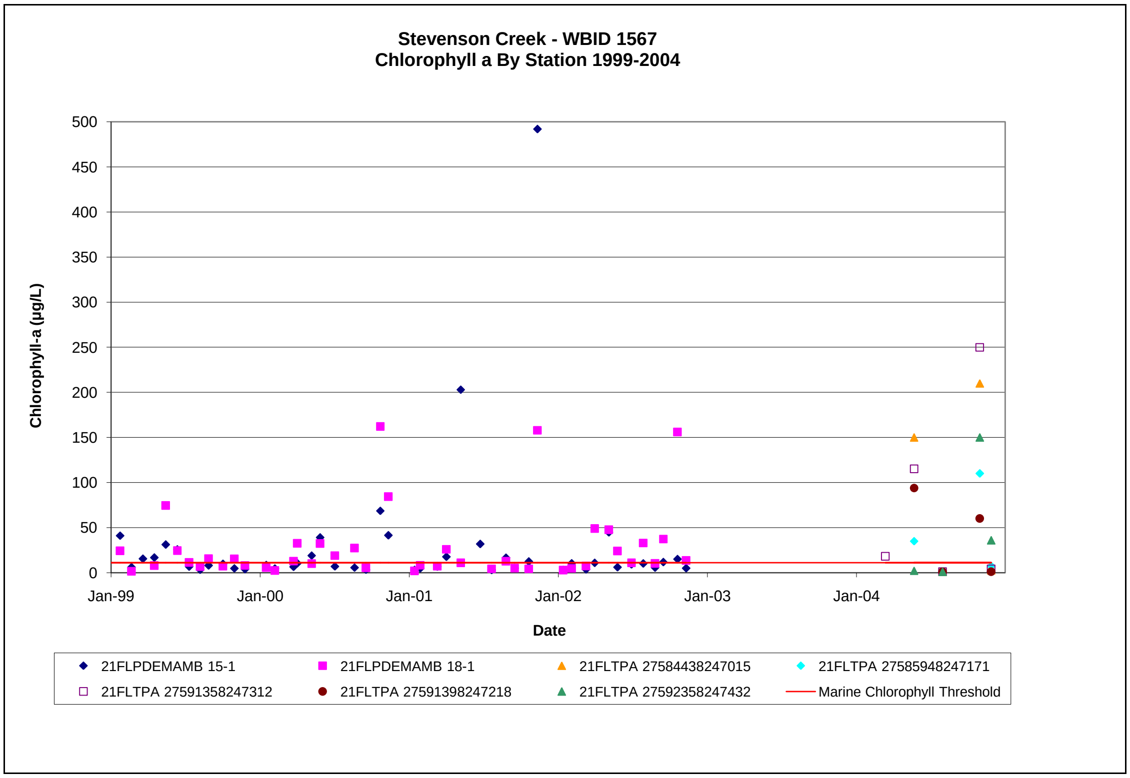

Figure 4 Chlorophyll a Measurements in the Stevenson Creek Tidal Segment, WBID 1567, During the Verified Period.

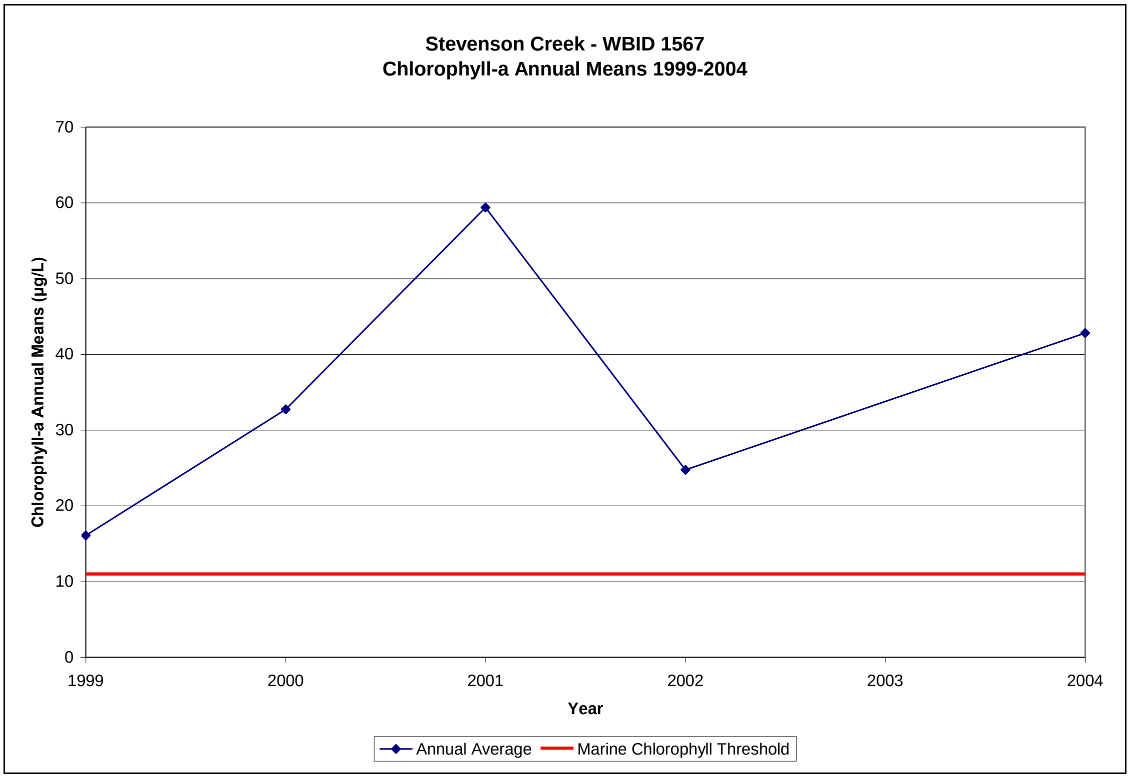

Figure 5 Chlorophyll a Annual Averages in the Stevenson Creek Tidal Segment, WBID 1567, During the Verified Period.

As part of the verified listing process, the Department attempts to identify the limiting nutrient or nutrients for the impaired waterbody. The limiting nutrient, generally nitrogen or phosphorus, is defined as the nutrient that limits plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll a, and macrophytes to grow. Once the limiting nutrient in a waterbody is exhausted, algae stop growing. If more of the limiting nutrient is added, larger algal populations will result until nutrients or other environmental factors again limit their growth.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients, and nitrogen is typically the limiting nutrient in most Florida estuaries. There is a general understanding in the marine scientific community that nitrogen is the principal cause of nutrient over enrichment in coastal systems (National Research Council 1993 and 2000) and an analysis of the data from the Stevenson Creek tidal segment supports this conclusion.

Determining the limiting nutrient in a waterbody can be accomplished by calculating the ratio of nitrogen to phosphorus in the waterbody, with water column ratios of total nitrogen (TN) to total phosphorus (TP) of less than 10 indicating that nitrogen is limiting. The median TN to TP ratio is 5.8 (computed from n=117 values), indicating that nitrogen is the limiting nutrient in the tidal segment of Stevenson Creek.

Since nitrogen is the limiting nutrient, reductions in TN loadings would be expected to result in decreases in algal growth, and are measured as decreases in chlorophyll a levels. Reductions in

TN loading are also expected to result in additional benefits of concern, including DO and biochemical oxygen demand (BOD). BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions (Sawyer & McCarty, 1967). Reductions in nutrients will result in lower algal biomass levels in the water column, and lower algal biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids, and reduced BOD.

3.0 DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

The tidal portion of Stevenson Creek is a Class III estuarine waterbody, with designated uses for recreation, and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the impairment addressed by this TMDL are for DO and the narrative nutrient criteria.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 Dissolved Oxygen Criterion

The Class III marine criterion for DO, as established by Subsection 62-302.530(30), F.A.C., states that DO shall not average less than 5.0 mg/L in a 24-hour period, and shall not be less than 4 mg/L, and that normal daily and seasonal fluctuations above these levels shall be maintained.

3.2.2 Interpretation of Narrative Nutrient Criterion

Florida's nutrient criterion is narrative only—nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for estuaries based on annual average chlorophyll *a* levels, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. In fact, in recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Section 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

In translating the narrative nutrient criterion for this TMDL, the Department selected estuarine segments not impaired for nutrients to identify a target chlorophyll a concentration for establishing the TMDL. **Table 4** summarizes results for the estuarine segments where the average chlorophyll a concentrations are less than the 11 ug/L impairment threshold for estuaries. These waters include both open water estuarine segments and tidal stream segments in the area of Stevenson Creek. Given the uncertainty of nutrient reactions within estuaries, the Department applied a chlorophyll a target of 8 ug/L for establishing the TMDL, which falls within the range of average chlorophyll a concentrations in the estuarine waters not impaired for nutrients. Using this target value for establishing the TMDL should result in annual average chlorophyll a values below the impairment threshold for estuaries of 11 ug/L. This approach minimizes the potential for listing the water as impaired in the future.

Table 4 Summary of Chlorophyll a Results for Estuary Segments Not Impaired for Nutrients.

WATER SEGMENT	WBID	Average Chlorophyll a (ug/L)[a]
CLEARWATER HARBOR SOUTH	1528	7.6
THE NARROWS	1528A	8.3
DIRECT RUNOFF TO INTERCOASTAL WATERWAY	1528B	7.8
CLEARWATER HARBOR NORTH	1528C	6.4
BOCA CIEGA BAY CENTRAL	1694A	6.5
BOCA CIEGA BAY NORTH	1694B	7.2
BOCA CIEGA BAY	1694C	8.2
ST. JOSEPH SOUND	8045D	4.9
DIRECT RUNOFF TO GULF (MINNOW CREEK)	1535	5.1
ANCLOTE RIVER TIDAL SEGMENT	1440	4.3

[a] Averages calculated from results collected during the 1994 to 2006 period as contained in IWR Database Run 28.

4.0 ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutants of concern in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over 5 acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL. However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this chapter does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 NPDES Permitted Wastewater Facilities

There is one permitted domestic wastewater treatment facility in the watershed that has a surface water discharge, the City of Clearwater-Marshall Street Advanced Wastewater Treatment Plant (AWWTP),NPDES No. FL0021857. The Marshall Street AWWTP is a domestic wastewater treatment facility with a design flow of 10 million gallons per day (MGD) (FDEP, March 23, 2007). A portion of the treated effluent from this facility is re-used for irrigation on public-access areas under the City of Clearwater Master Reuse System (Permit No. FL186261) The reclaimed water may provide an indirect source of nutrients impacting Stevenson Creek. The remaining treated effluent is discharged directly into the tidal portion of Stevenson Creek, via Outfall D-001, which is located approximately 0.8 miles upstream of the creek's mouth. The point of discharge in Stevenson's Creek is located 20 feet from shore at a depth of 4 feet, and is at latitude 27° 58' 58"N, and longitude 82° 47' 15"W. **Figure 6** displays the location of the surface water outfall and reuse system application points in the watershed.

4.2.2 Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may also discharge pollutants to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase 1, promulgated in 1990, addresses large and medium-size MS4s located in incorporated areas and counties with populations of 100,000 or more. Phase 2 permitting began in 2003. Regulated Phase 2 MS4s are defined in Section 62-624.800, F.A.C., and typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharging into Class I or Class II waters, or into Outstanding Florida Waters.

The stormwater collection systems in the Stevenson Creek watershed, which are owned and operated by Pinellas County in conjunction with the Florida Department of Transportation (FDOT) District 7, are covered by a Phase 1 MS4 permit (Permit No. FLS000005) (FDEP, 2006). The cities of Clearwater, Dunedin and Largo are co-permittees in the MS4 Permit which have land area within the Stevenson Creek watershed. Currently, no local governments in the watershed have applied for coverage under the Phase 2 NPDES MS4 permit.

Figure 6 Wastewater Facilities and Discharge Sites in the Stevenson Creek Watershed.

4.3 Land Uses and Nonpoint Sources

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Because the Stevenson Creek watershed is primarily urban, agricultural fertilizing or nutrients from wildlife and agricultural livestock wastes are not expected to contribute significantly to the TN load.

4.3.1. Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD 2004 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library. According to the Florida Land Use and Cover Classification System (FLUCCS), there are 26 land use categories (Level 4) within the Stevenson Creek watershed. For the purpose of this report, and considering the most predominant land use categories in the Stevenson Creek watershed, the FLUCCS land use categories were aggregated into nine groups for modeling purposes and are presented in **Table 5** with their respective distribution within each of the model sub-watersheds (CDM and DS, 2009). Land use categories in the watershed were aggregated using the simplified Level 1 codes **(Table 5). Figure 7** shows the acreage of the principal land uses in the watershed. Land use is predominately urban and residential, with over 75 percent of the land area developed into residential areas. The next largest land use is commercial and industrial at 10.4 percent of the combined watershed land area, and over 7 percent is recreational area, comprised mostly of golf courses. Natural land uses (water and wetlands) represent some 4.9 percent of the area and transportation/communications/utilities take up about 2 percent of the area.

Table 5 Classification of Land Use Categories in the Stevenson Creek Watershed in 2004.

Land Use	Acreage					
	Hammond Branch	Lower Stevenson	Spring Branch	Upper Stevenson	Total	% of Watershed
Commercial / Industrial	40.2	70.8	129.8	415.9	656.6	10.4
Cropland / Upland Forest	5.7		38.2	4.8	48.7	0.8
Recreational / Open Land	123.3	91.7	59.7	174.4	449.0	7.1
Residential High Density / Institutional	38.4	30.5	143.5	83.2	295.6	4.7
Residential Low Density: < 2 DU/ac			58.5	8.8	67.3	1.1
Residential Med Density: 2 to 5 DU/ac	647.1	393.3	1,551.9	1,786.4	4,378.6	69.6
Transportation / Utilities	23.8	19.2	54.4	37.6	134.9	2.1
Water	26.5	35.2	60.1	64.9	186.6	3.0
Wetlands	0.8	6.3	55.5	8.4	70.9	1.1
Total	905.7	646.9	2,151.5	2,584.3	6,288.4	100.0

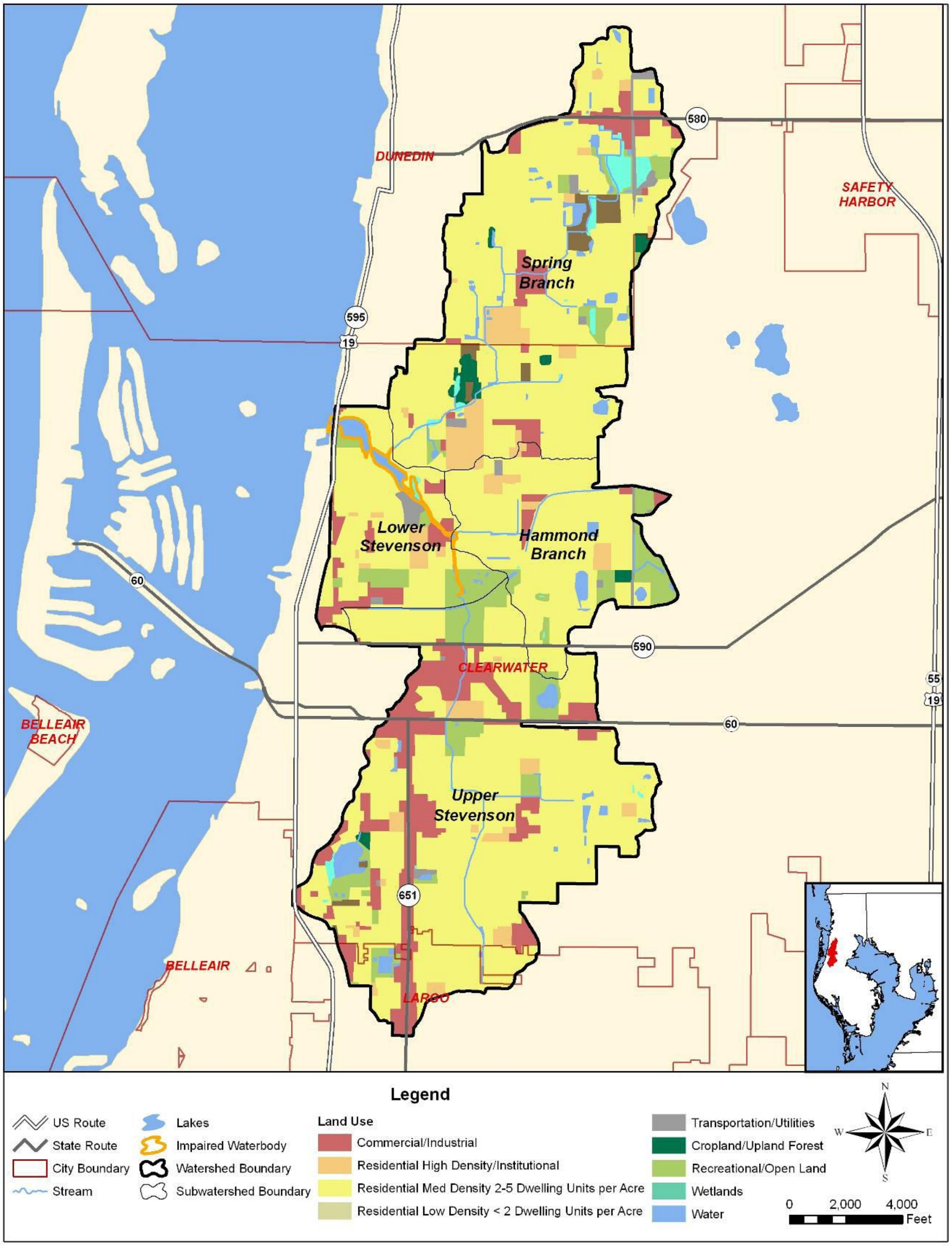

Figure 7 Principal Land Uses in the Stevenson Creek Watershed in 2004.

4.3.2 Estimating Nonpoint Source Loadings

The nonpoint source loadings of BOD, expressed as Ultimate Carbonaceous Biochemical Oxygen Demand ($CBOD_u$), and nutrients (TN and TP) generated in the Stevenson Creek watershed for the 1999 to 2006 period, were estimated for stream baseflow, septic systems, and surface water runoff using the *Hydrologic Simulation Program - FORTRAN* (HSPF) model. A detailed description of the HSPF model applied to the watershed is available in the TMDL model development report (CDM and DS, 2009). The model simulated annual average nonpoint source pollutant loadings are provided in **Table 6**. The following briefly describes the methods used to develop the loading estimates.

Ground Water

Baseflow

Baseflow represents ground water discharge to streams. The annual baseflow discharge and load were computed for each of the sub basins that drain to Stevenson's Creek. Estimated annual base flows, including interflows, for all sub-watersheds are included in Tables 4-7 through 4-10, in acre-ft per year, in the model development report (CDM and DS, 2009). Interflow is defined as that ground water flow from the soil zone above the ground water table.

Groundwater quality data was obtained from wells in the upper parts of the Stevenson Creek

Watershed or from wells located just outside of the watershed boundary (refer to Figure 2-6 in the model development report). Samples from these wells were analyzed for a large set of constituents, including nutrients that are 303(d) listed in surface waterbodies. Most of the available data from Pinellas County for these wells were collected between the years 1990 through 1999, with one sample in 2003 (CDM and DS, 2009).

Average annual pollutant loadings from base flows, as simulated with the HSPF model were estimated in pounds per year. These loads are included for all sub-watersheds in Section 4 of the TMDL model development report (CDM and DS, 2009).

Septic Systems

The locations of septic tanks within the Stevenson Creek watershed, as shown in GIS data published by the Florida Department of Health, are displayed in **Figure 8**. The number of septic tanks in the watershed based on this information is 487. The loading impacts of failing septic tanks are addressed by increasing the surface runoff loading calculated by the HSPF model. The failing septic tank loading rate of 10% was used as per the FDEP protocol (FDEP, 2006). To account for septic system loadings, the HSPF model was adjusted to match the estimated annual loadings through the use of accumulation/washoff, interflow and base flow parameters. Values used in the septic tank load calculations may be found in the TMDL model development report (CDM and DS, 2009).

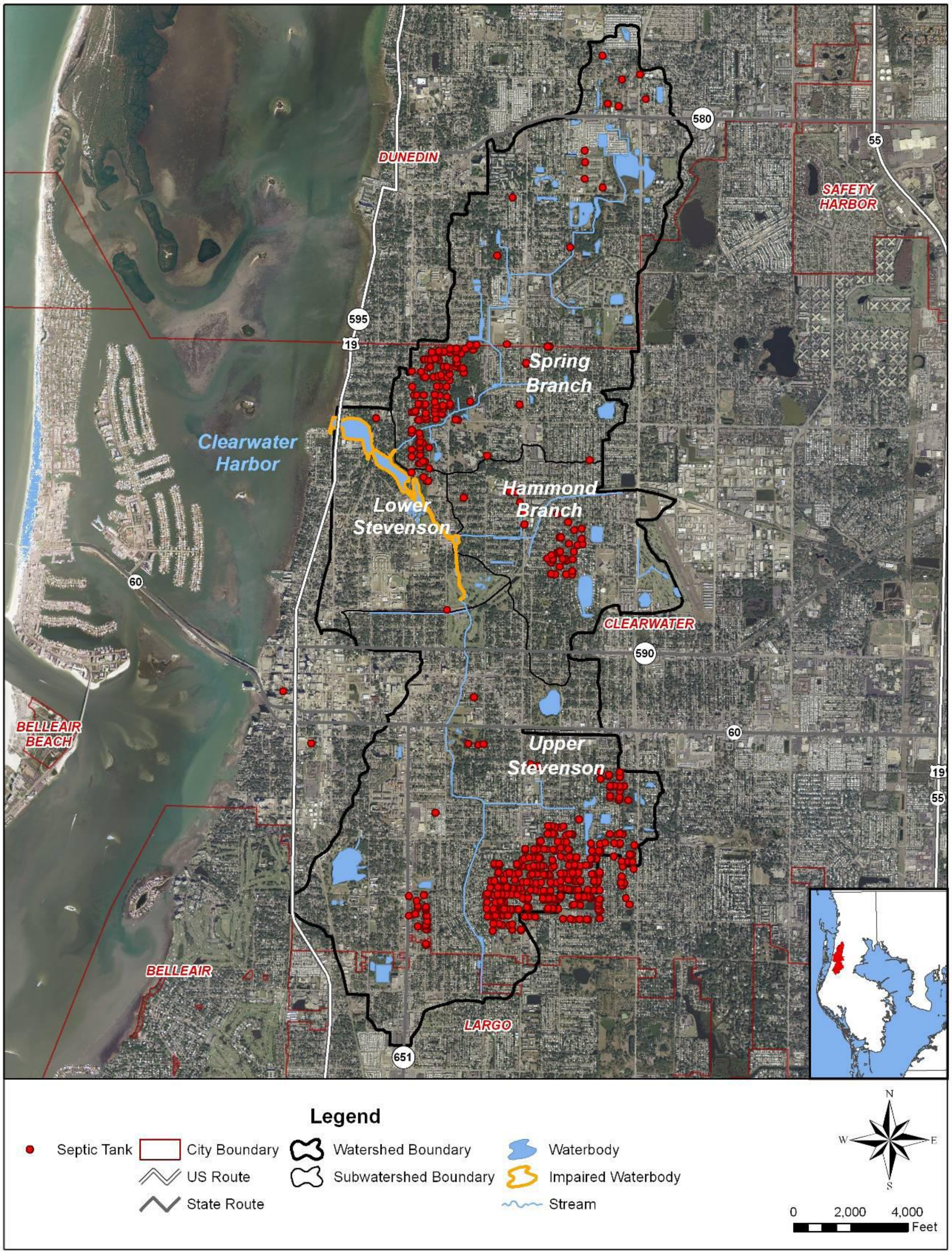

Figure 8 Septic Tank Locations within the Stevenson Creek Watershed.

Surface Water Runoff

The HSPF model was used to estimate the watershed surface water runoff loads associated with rainfall. The model is designed to simulate the annual hydrologic (stream flows) and associated water quality (pollutant loads) from pervious and impervious land surfaces based on land use.

A discussion of the HSPF's model development, parameters and input data is included in Section 4 of the model development report (CDM and DS, 2009). The HSPF simulated surface water runoff flows for all sub-watersheds may be found in Tables 4-7 through 4-10 in the model development report. Additionally the annual and average annual simulated watershed loading rates (in lbs/acre/year); and the simulated total loads for each pollutant for all sub-watersheds is included.

Table 6 Annual Average Watershed Nonpoint Source Loads to the Stevenson Creek Tidal Segment.

Total Nonpoint Source Loading (lbs/year)			
YEAR	Total Phosphorus	Total Nitrogen	CBODu
1999	3,262	36,092	91,162
2000	2,405	27,110	59,871
2001	3,725	37,469	127,333
2002	4,795	46,625	170,619
2003	6,199	57,035	259,748
2004	8,844	62,394	469,895
2005	3,232	36,593	79,893
2006	4,078	38,343	152,224
AVERAGE	4,568	42,708	176,343

$CBOD_u$ = Ultimate Carbonaceous Biochemical Oxygen Demand

TN = Total Nitrogen

TP = Total Phosphorus

5.0 DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The goal of this TMDL development is to identify the maximum allowable total nitrogen (TN) and carbonaceous biochemical oxygen demand (CBOD) loadings from point and nonpoint sources in the watershed, so that the Stevenson Creek tidal segment (WBID 1567) will meet the DO water quality criterion and the narrative nutrient water quality criterion, thereby maintaining it's function and designated use as a Class III marine water. The DEP contracted with Camp, Dresser & McKee, Inc. and Dynamic Solutions, LLC to develop a watershed pollutant loading model and a surface water hydrodynamic and water quality model. The *Hydrologic Simulation Program - FORTRAN* (HSPF) model was selected as the watershed-scale loading model, and the *Environmental Fluid Dynamics Code* (EFDC) model was selected as the receiving water hydrodynamic and water quality model. Details on the set up, calibration, and validation of each model are documented in the report entitled, Stevenson Creek Watershed TMDL Model Development (CDM and DS, 2009). After the models were completed for the Stevenson Creek system, the DEP applied them in assessing pollutant load reductions required for the tidal reach of the creek to meet the applicable criteria for DO and nutrients.

The HSPF model was used to conduct the watershed hydrodynamic modeling to generate watershed flows associated with each of the aggregated land use categories from each of the freshwater tributaries. HSPF flows and selected pollutant loading rates, as mentioned previously in Chapter 4, were used to conduct watershed loading calculations. The output from the HSPF model provided hydrodynamic and water quality constituent input needed for the EFDC model to simulate the hydrology and water quality of the Stevenson Creek tidal segment.

In the set up of the EFDC model for the tidal creek, Clearwater Harbor served as the downstream boundary condition. Inflow boundaries to the EFDC model domain are provided by the HSPF model output of flow volumes and water quality concentrations developed for the sub-watersheds, representing the nonpoint source loadings, and the effluent discharge monitoring data for the Clearwater – Marshall St. AWWTP facility, representing the point source loading. Appendix A of the TMDL model development report summarizes the development of the St. Joseph Sound/Clearwater Harbor Hydrodynamic Model that was used to generate boundary conditions for the downstream end of the EFDC model (CDM and DS, 2009).

The hydrodynamic and water quality time series results for each model boundary component were linked as input to the EFDC model to simulate hourly DO and chlorophyll a responses in the tidal creek. Each model was calibrated and validated using the available hydrologic data and water quality results collected in the Stevenson Creek watershed and in nearby Clearwater Harbor. The comparisons of model simulated results to observed data are provided in the TMDL model development report (CDM and DS, 2009). The water quality models were calibrated and validated using surface water quality data contained in the IWR Database that were collected between 1999 and 2006. Monitoring results collected after 2006 were also evaluated and the results show that water quality in both the tidal and freshwater segments do not exhibit trends over time and has remained fairly constant since 1999. Water quality results for chlorophyll a, DO, total nitrogen, and BOD5, contained in the IWR Run 44 Database, that were collected from 1999 to the present are displayed in the graphs in Appendix C.

Other models implemented on this project included an "AdlCPR" model that was developed as part of the Stevenson Creek Watershed Management Plan, to characterize stage, discharge, and cross-sectional area relationships for select cross-sections of stream reaches in the model. Channel section geometry data was imported into a Hydraulic Engineering Center River Analysis System" (HEC-RAS) model, to simulate water depth and cross sectional area at different downstream flow rates. Other supporting models, not mentioned in this report, are documented and referenced in the TMDL model development report (CDM and DS, 2009).

Although the focus of this TMDL is reductions in BOD and nutrient loadings to address the DO and nutrient impairments, other factors can affect the DO in surface waters. These factors include: reaeration, temperature, salinity, color, light transmission, total suspended solids (TSS) and sediment parameters such as sediment oxygen demand (SOD) and nutrient flux rates.

5.2 Overview of the Hydrologic Simulation Program FORTRAN (HSPF) Model

The HSPF model was used to simulate both hydrologic and water quality loads in the watershed and freshwater tributaries. The US EPA and USGS jointly developed the modifications to the original model for water quality purposes in the 1980s. Information about the model may be found at the USGS website provided in the reference section. Detailed information about the set up, input data, and application of the HSPF model to the Stevenson Creek watershed is documented in the TMDL model development report (CDM and DS, 2009). The data used to develop this dynamic model includes information on rainfall, solar radiation, temperature (air and dew-point), evapotranspiration, ground elevation, stream reach channel characteristics (cross sections, lengths and volumes), stream flows and stages, watershed inflows and withdrawals, land use classifications, hydrologic soil groups, pollutant loading coefficients, baseflow concentrations and water quality concentrations.

5.3 Overview of the Environmental Fluids Dynamics Code (EFDC) Model

The Environmental Fluid Dynamics Code (EFDC) model is a general-purpose modeling package designed to simulate 1-dimensional, 2-dimensional, and 3-dimensional flow, transport, and bio-geochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and near shore to shelf scale coastal regions. The public domain EFDC model, originally developed at the Virginia Institute of Marine Science for estuarine and coastal applications, is supported by the EPA.

The EFDC Explorer program was used to set-up and apply the EFDC model to the Stevenson Creek tidal surface water reach to simulate the three dimensional hydrodynamic and water quality characteristics of the system (CDM and DS, 2009). To efficiently test, setup and calibrate EFDC models, Dynamic Solutions, LLC developed the EPA-licensed EFDC_Explorer pre- and post processor. EFDC_Explorer, developed to support the EFDC sub-models for hydrodynamics, sediment transport, toxic chemicals, water quality and sediment diagenesis, is a public domain, Windows-based GUI available from Dynamic Solutions. EFDC_Explorer is designed to support EFDC model set-up and configuration, grid generation (cartesian or curvilinear), model testing, calibration and validation. EFDC_Explorer provides the capability for data visualization, including display of the computational grid, map overlays, spatial results, time series and vertical profile plots. Information on EFDC_Explorer is available in the user's manual (Craig, 2008) and at the Dynamic Solutions web site identified in the reference section.

The Stevenson Creek tidal segment was segmented into curvilinear computational grid cells representing three dimensions, using bathymetric data, for the hydrodynamic and water quality model. A discussion of the grid development, bathymetry and model boundary conditions is contained in the TMDL model development report (CDM and DS, 2009).

5.4 HSPF Model Calibration and Validation

The HSPF model was set up, refined, calibrated and validated. The HSPF model was developed to simulate Stevenson Creek watershed stream flows and water quality constituent loads for the period beginning on January 1, 1999 and ending on December 31, 2006. Simulated results were compared against observed ambient water quality monitoring data collected between 1999 and 2006.

The period from August 2006 through December 2006 was chosen as the HSPF stream flow calibration period, and the period from February 2004 through March 2005 was chosen as the HSPF stream flow validation period. Simulated stream flow was calibrated against instantaneous flow measurements collected by Pinellas County during routine monitoring at stations 21FLPDEM18-03, and 21FLPDEM15-04 for Upper Stevenson Creek and Spring Branch, respectively. Results indicated that the flow calibration was quite good for both streams. A discussion of the calibration/validation process and results can be found in Chapter 4 of the TMDL model development report (CDM and DS, 2009).

Based on available ambient water quality data, the period from January 1, 2003 through December 31, 2004 was chosen as the HSPF model water quality calibration period, and the period from January 1, 2005 through December 31, 2006 was chosen as the HSPF model validation period.

Upper Stevenson Creek and Spring Branch were calibrated for water quality parameters as follows:

- Water Temperature - ^{o}F
- Dissolved Oxygen (DO) – mg/L
- Chlorophyll a – *u*g/L
- Total Phosphorus (TP) – mg/L
- Orthophosphates – mg/L
- Total Nitrogen (N) – mg/L
- Total Kjeldahl Nitrogen (TKN) – mg/L
- Nitrite plus Nitrate Nitrogen – mg/L
- Ammonia Nitrogen (NH_4) – mg/L
- Carbonaceous Biochemical Oxygen Demand ($CBOD_u$) ultimate – mg/L

In the case of $CBOD_u$ there are no direct measures of $CBOD_u$ in the surface waters. To evaluate model performance with respect to BOD, the BOD_5 ambient monitoring results were converted to $CBOD_u$ using a multiplier of 2.47, as recommended in EPA guidance (USEPA, 1997), in the absence of site specific data.

Figures and tables providing the simulated (modeled) and/or observed data for all waterbody segments may be found in Sections 4.3.3 through 4.3.6 of the TMDL model development report (CDM and DS, 2009).

5.5 HSPF Model Sensitivity

A model sensitivity analysis was performed to identify the model parameters that have or do not have a significant influence on model simulations. Various parameter changes were made to test the sensitivity of the model. Results of the sensitivity analysis included that stream flow rate was sensitive to the percent impervious cover. Model water quality parameters were determined to be sensitive to watershed loadings, sediment oxygen demand (SOD) and algal growth rate. HSPF model sensitivity is discussed in Section 4.5 of the TMDL model development report (CDM and DS, 2009).

5.6 EFDC Model Calibration

The primary period selected for water quality model calibration was from January 1, 2004 to December 26, 2004. This period has an adequate set of salinity, temperature, meteorology, and water quality data for setting boundary conditions and calibrating the model.

The source of the data for the calibration period of 2004 was from sampling performed by the FDEP Southwest District office. The stations with their full station names and STROET ID numbers are listed below:

- TP283-Stevenson Creek, 27592358247432
- TP284-Stevenson Creek, 27591358247312
- TP282-Stevenson Creek, 27585948247171
- TP285-Stevenson Creek, 27584438247015

The locations of the stations are shown in **Figure 1.2**.

Since there were no tide or water level gages within the tidally influenced region of Stevenson Creek, a short record of relative water depths, collected by the US Army Corps of Engineers on June 25-26, 2002, was used to calibrate the tidal fluctuations.

The model initial conditions and boundary conditions are discussed in Section 4.7.1; the EFDC hydrodynamic and water quality model calibration results are presented in Sections 4.7.2 through 4.7.4. (including calibration plots and supporting tables) of the final TMDL model development report (CDM and DS, 2009). A complete set of calibration plots may be found in Appendix B of the TMDL model development report (CDM and DS, 2009).

In accordance with the FDEP TMDL protocol, a statistical methods analysis using the "root mean squared" (RMS) was performed. As per the protocol, "the RMS error should ideally be no greater than potential gaging, sampling, and laboratory errors inherent in the measured data." RMS is also called the "standard deviation," and it is in the same units as the evaluated data. The summary Tables 4-33 through 4-35, in the final TMDL model development report (CDM and DS, 2009), for the calibration runs, show that the model results were all within the estimated error ranges for water elevation, temperature and salinity. Table 4-41, of this same report, shows the calibrated and RMS results for the water quality parameters.

5.7 EFDC Model Validation

The period selected for model validation was a four-year period ranging from January 1, 1999 to December 31, 2002. The observed data used for validation was from the Pinellas County water quality monitoring program. The two stations chosen were 21FLPDEM AMB 18-1 and 21FLPDEM AMB 15-1. The station locations are identified in **Figure 2**.

Section 4.8 of the final TMDL model development report outlines the changes in the boundary conditions for validation, hydrodynamics, and water quality (CDM and DS, 2009). Time series validation plots for flow, salinity, water temperature, DO and chlorophyll a for both the water surface and bottom layers are included in this report. A complete set of validation plots may be found in Appendix C of the TMDL model development report (CDM and DS, 2009).

5.8 EFDC Model Sensitivity

A sensitivity analysis of the EFDC model was performed. The base model for this analysis was the calibrated model for the year 2004. Sixteen model runs with different parameter values were run to investigate the model sensitivity.

A discussion of the sensitivity analysis run descriptions and results are included in Section 4.9 of the TMDL development report (CDM and DS, 2009). The conclusions were that the model was not very sensitive to the range of parameter variation analyzed; however, raising the algal growth rate improved the Chlorophyll a RMS, but negatively impacted the DO and nutrient RMSs. The SOD also had a significant effect on DO concentrations in the surface water and to a lesser degree the related benthic nutrient fluxes and nutrient concentrations in the surface water.

5.9 Determination of Loading Capacity

The calibrated and validated HSPF and EFDC models developed for Stevenson Creek are designed to assist in predicting future water quality responses, as a result of reductions in existing pollutant loads, in order to determine the waterbody's assimilative capacity to meet the applicable DO and nutrient surface water quality criteria and establish the TMDLs. The models simulate the eutrophication processes in the freshwater tributaries and the tidal segment of Stevenson Creek.

The contractors provided the models set up to simulate conditions during the 1999 to 2006 period. The DEP applied the models in assessing pollutant load reductions required for the tidal reach of the creek to meet the applicable criteria for DO and nutrients. The loading capacity for the tidal segment was determined by performing multiple model design runs where the point source and nonpoint source loads were adjusted until the applicable water quality targets were met.

Reductions in both point source loads, from the Clearwater – Marshall St. AWWTP, and watershed nonpoint source loads were evaluated with the EFDC model of Stevenson Creek to determine a load reduction alternative for meeting the water quality targets and setting TMDLs for biochemical oxygen demand and total nitrogen loadings.

As a result of reduced loadings, the SOD and benthic nutrient flux rates are expected to be reduced as a result of reduced inputs of organic matter, primarily in the form of algal biomass, deposited to the stream sediments. Therefore, the SOD and benthic nutrient flux rates were modified to account for this mechanism. The approach chosen for adjusting SOD and benthic nutrient flux rates was to use a linear relationship between the rates and the organic carbon content of sediment related to water column primary productivity. The formula for the linear assumption that reductions in SOD and benthic nutrient flux rates are directly related to reductions in algal (phytoplankton) primary productivity is as follows:

$$(SOD)_{rev} = \frac{(Chl\ a)_{out}}{(Chl\ a)_{cal}} \times (SOD)_{cal}$$

Where:

$(SOD)_{rev}$ is the revised SOD (or benthic ammonia and/or phosphorus flux) rate under the reduction scenario under evaluation;

$(Chl\ a)_{out}$ is the chlorophyll a annual average value from the reduction scenario model run;

$(Chl\ a)_{cal}$ is the chlorophyll a annual average value from the calibrated model run;

$(SOD)_{cal}$ is the SOD (or benthic ammonia and/or phosphorus flux) rate from the

calibrated model run

Note: The Chl a annual averages used in these SOD and benthic nutrient flux rate revisions were calculated following the IWR methodology.

After each load reduction scenario was completed, the same EFDC model was re-run with the revised SOD and benthic nutrient flux rates. The DO and chlorophyll a results from the model runs with the adjusted sediment rates were then evaluated against the appropriate water quality targets. The simulated results from the EFDC model that were compared to the water quality targets were obtained from the model grids where ambient monitoring stations used for model calibration and validation are located. The sampling stations along with the EFDC model grid domain are presented in **Figure 9**.

The objective of the evaluation for establishing the TMDLs was to identify a model scenario where the predicted average chlorophyll a value would not exceed the selected target of 8 ug/L and result in DO conditions that would allow the tidal creek to meet the minimum DO criterion of 4 mg/L.

During the evaluation of alternative load reductions, model design scenarios were run with the Clearwater-Marshall St. AWWTP discharging at the current permitted flow of 10 MGD and at a flow of 5 MGD, which is approximately the average flow observed during the 1999 to 2006 period. Additionally, the model was run at effluent concentrations equal to the Advance Wastewater Treatment (AWT) concentration limits in the existing permit. As the facility AWT limits are beyond technology-based effluent treatment levels for TN and BOD, some design runs were evaluated that maintained the maximum permitted limits for the AWWTP, while focusing the load reduction on the nonpoint sources. Additionally, TP loads reductions were not included in the evaluation for establishing the TMDL, as the chlorophyll a response to AWWTP TP load reductions was determined to be negligible.

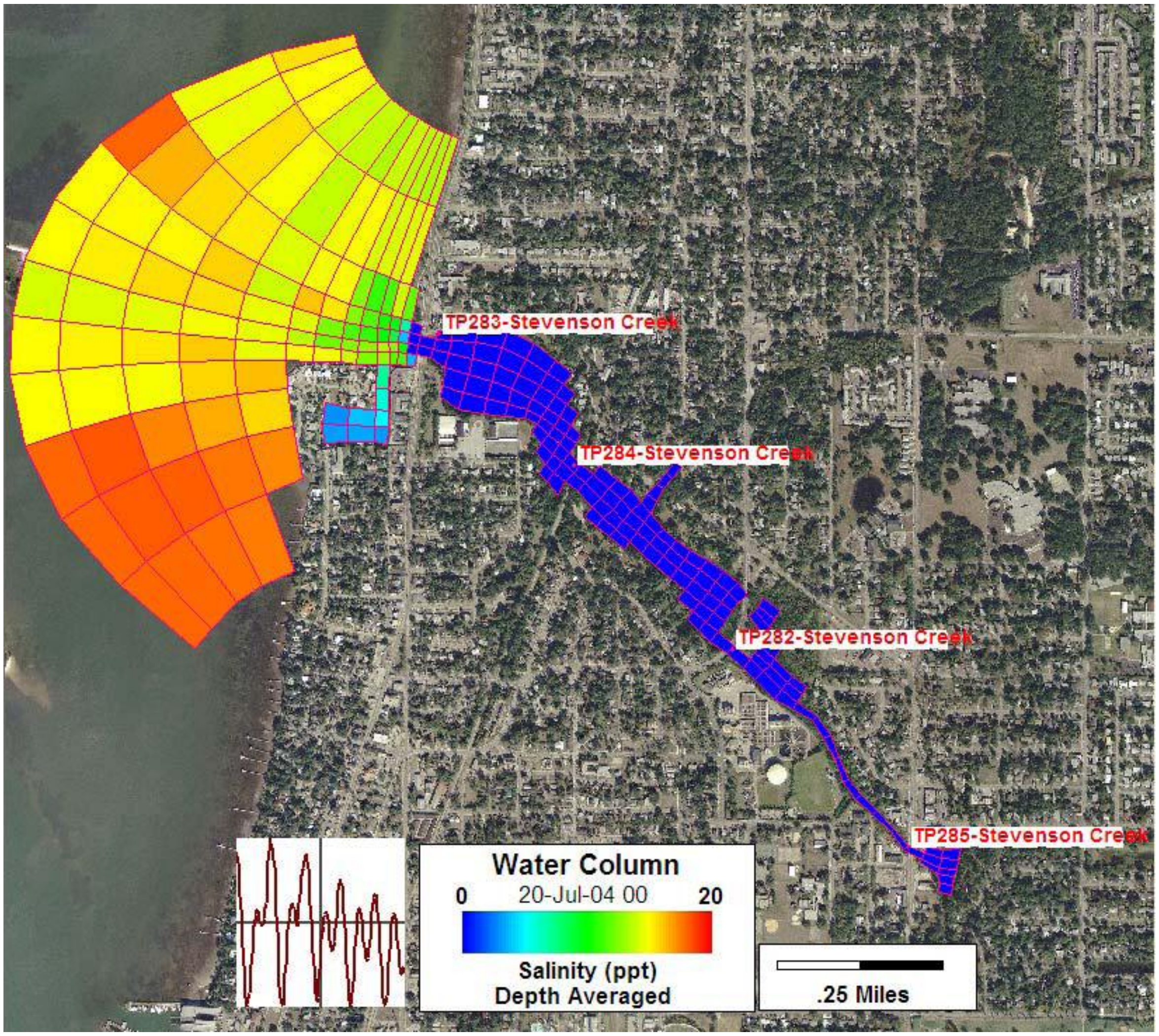

Figure 9 EFDC Model Domain with Monitoring Stations Used for Calibration.

After each design scenario was completed, the percent DO exceedances (< 4 mg/L), and average chlorophyll a value were determined. Annual average chlorophyll a values were calculated following the IWR methodology for each model grid location, where a sampling station is located. The average of the annual average concentrations at each sampling location was calculated for comparison to the chlorophyll a target.

The model results indicate that Stevenson Creek water quality is responsive to the discharge flow volumes applied in the design scenarios. For the model design run using the existing permit effluent limits for the Clearwater-Marshall St. facility (permitted flow of 10 MGD), the percent DO exceedance rate and average chlorophyll a concentrations are much lower than the values for the model scenario with the facility discharge flow rate at 5 MGD, **Table 7**. This can be partially attributed to higher discharge flow volumes from the AWWTP resulting in lower water residence times, which aids in flushing of the tidal creek.

The selection process for identifying the load reduction scenario for establishing the TMDL took into consideration what the AWWTP discharge flow volumes are reasonably expected to be. As a large quantity of the treated effluent goes to reuse and the plant inflow is considerably less than the permitted capacity of 10 MGD, an AWWTP flow volume of 5 MGD was used in the model design runs for determining the assimilative capacity of the tidal segment. During the 1999 to 2006 period, the Clearwater-Marshall St. facility annual average flow volume was slightly less than 5 MGD. In general, during recent years the effluent flow volumes discharged to the creek have been decreasing while in the same period flow volumes going to reuse have increased, **Figure 10**. In this circumstance, the current discharge volume is a more realistic flow to apply in the model scenarios for evaluating the impacts of the point source discharge along with load reductions from nonpoint sources.

A summary of the model predicted DO and chlorophyll a results for the existing loading conditions (baseline) and the alternative load reduction scenarios evaluated are presented in **Table 7**. The load reduction scenario selected for establishing the TMDLs includes an 85 percent nonpoint source (NPS) reduction in BOD and TN along with the Clearwater-Marshall St AWWTP discharging at an average flow rate of 5 MGD and at the following average effluent concentrations: CBOD5 = 5 mg/L; TN = 2.2 mg/L; and DO = 7 mg/L. The AWWTP facility effluent flow rate and concentrations used in the model represent long term averages, as they were applied throughout the eight year model simulation period. Under this loading scenario, the DO exceedance rate is 9.4 percent and the average chlorophyll a concentration is 7.1 ug/L.

A model scenario was performed to predict tidal creek water quality at loadings that represent undeveloped natural conditions. Watershed loadings of TN for the undeveloped condition were derived by using the estimated annual mass loads from undeveloped/natural areas for each hydrologic soil group presented in Harper and Baker, 2007, and the area of each hydrologic soil group in the watershed presented in the TMDL model development report (CDM and DS, 2009). The natural background TN load is estimated to be 5,594 lbs/year, which is 13 percent of the existing watershed TN load. The undeveloped natural condition model scenario was simulated by reducing the existing TN and BOD watershed loads by 87 percent and removing the Clearwater-Marshall St AWWTP effluent discharge to the creek. The model results for this scenario predict additional reductions in chlorophyll a concentrations (average of 3.3 ug/L) but with a greater percent exceedance (12.7 percent) of the minimum DO criteria of 4 mg/L, **Table 7**. These results indicate that at watershed loads representative of natural background conditions, the DO regime in the tidal creek would still not meet the marine minimum DO criterion.

Table 7 Summary of Model Predicted Dissolved Oxygen and Chlorophyll a Results (1999-2006 Simulation Period).

Model Run	Total Number of Model Observations	Number of DO Values Less Than 4 mg/L	Percent of DO Values Less Than 4 mg/L	Average Chlorophyll a (ug/L)
Baseline - Current Conditions (1999 - 2006)	**58,400**	**22,515**	**38.6**	**11.7**
Design Run - 85% NPS Load Reduction; WWTF at 10 MGD Permitted Flow and $CBOD_5$ = 5.0 mg/L, TP = 1.0 mg/L, TN = 3.0 mg/L, DO = 5 mg/L	**58,400**	**2,676**	**4.6**	**4.0**
Design Run - 85% NPS Load Reduction; WWTF at 50% of Permitted Flow and $CBOD_5$ = 5.0 mg/L, TP = 1.0 mg/L, TN = 3.0 mg/L, DO = 5 mg/L	**58,400**	**7,059**	**12.1**	**7.9**
Design Run - 85% NPS Load Reduction; WWTF at 50% of Permitted Flow and $CBOD_5$ = 5.0 mg/L, TP = 1.0 mg/L, TN = 2.5 mg/L, DO = 7 mg/L	**58,400**	**5,812**	**10.0**	**7.4**
Design Run - 85% NPS Load Reduction; WWTF at 50% of Permitted Flow and $CBOD_5$ = 5.0 mg/L, TP = 1.0 mg/L, TN = 2.2 mg/L, DO = 7 mg/L	**58,400**	**5,473**	**9.4**	**7.1**
Design Run - 85% NPS Load Reduction; WWTF at 50% of Permitted Flow and $CBOD_5$ = 5.0 mg/L, TP = 1.0 mg/L, TN = 2.0 mg/L, DO = 7 mg/L	**58,400**	**5,331**	**9.1**	**6.8**
Design Run - 87% NPS Reduction, No WWTF Discharge (Natural Background Approximation)	**58,400**	**7,417**	**12.7**	**3.3**

Model run scenario shown shaded is selected for establishing the TMDL.

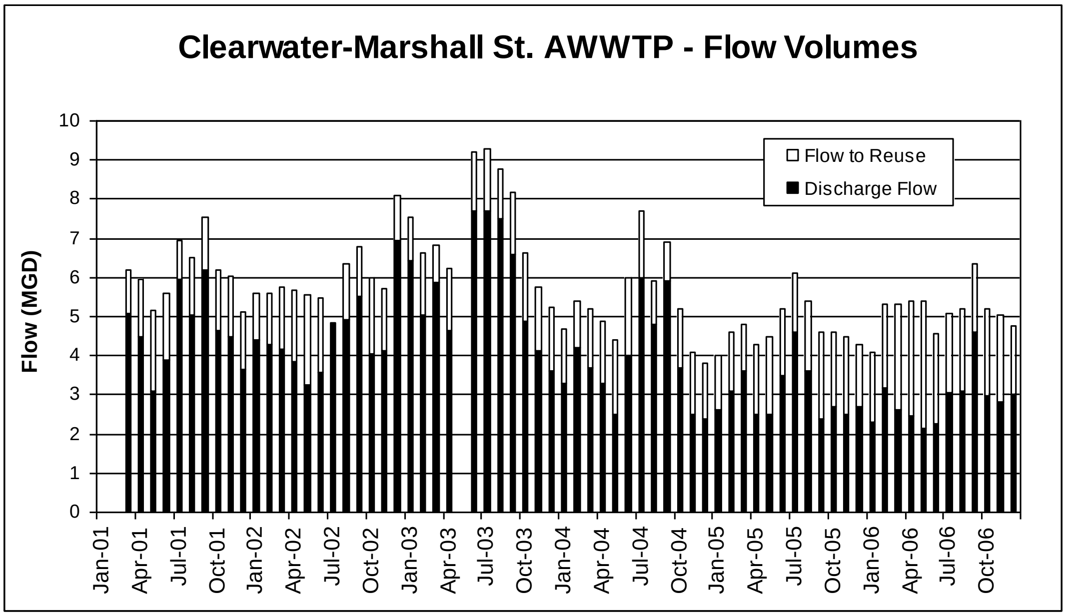

Figure 10 Clearwater-Marshall Street AWWTP Facility Flows to Reuse and Discharge to Stevenson Creek (2001 – 2006).

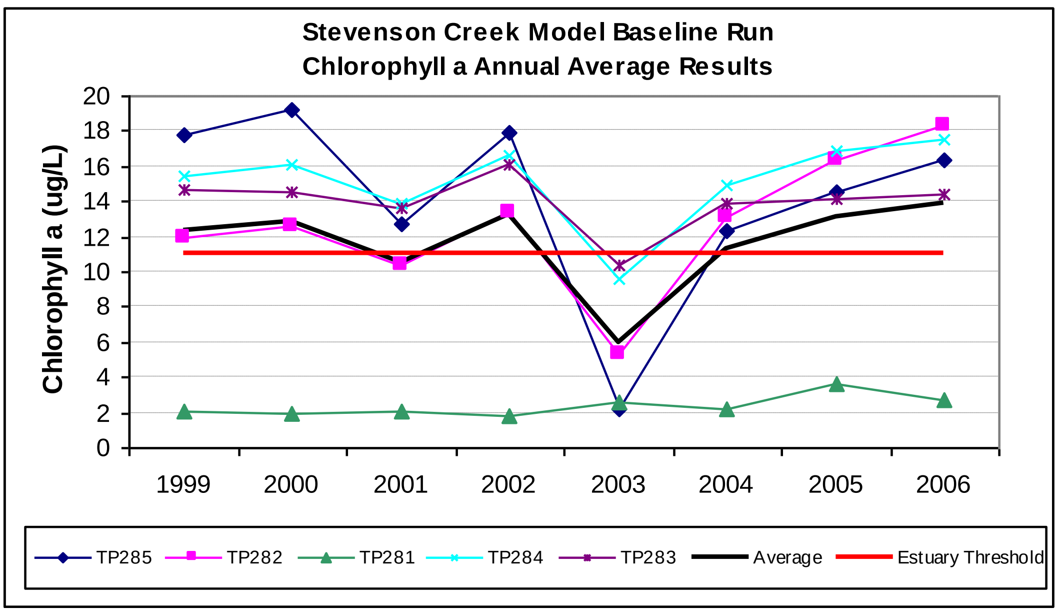

Figure 11 Predicted Annual Average Chlorophyll a Values for the Baseline Condition.

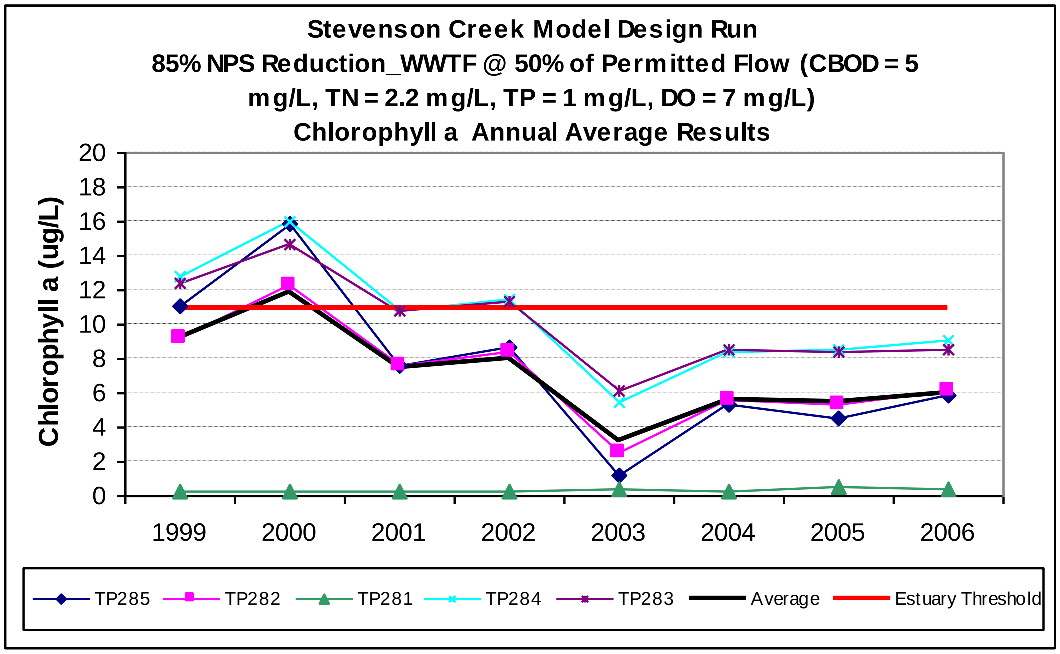

Figure 12 Predicted Annual Average Chlorophyll a Values for the Load Reduction Scenario Selected for the TMDL.

The predicted chlorophyll a annual averages used to calculate the overall chlorophyll a value for the current baseline condition and the selected load reduction scenario, are presented in **Figures 11 and 12**, respectively.

Based on the EFDC modeling results, the load reduction scenario selected for establishing the TMDLs, is expected to result in an average chlorophyll a less than the target of 8 ug/L, thereby achieving the narrative nutrient criteria, and result in an occurrence frequency of low DO that is similar to undeveloped natural conditions.

5.10 Critical Conditions

The TMDLs were based on conditions observed throughout the eight-year model simulation period rather than critical/seasonal conditions because the methodology used to determine impairment was based on water quality results collected throughout the year.

6.0 DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Waste Load Allocations, or WLAs), nonpoint source loads (Load Allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as "percent reduction" because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of BMPs.

This approach is consistent with federal regulation 40 CFR § 130.2[I] (U.S. Environmental Protection Agency, 2003), which states that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDLs for the Stevenson Creek tidal segment (WBID 1567) are expressed in terms of pounds per year and pounds per day in **Tables 8 and Table 9**, respectively. The TMDLs represent the maximum annual and daily load the tidal segment can assimilate to maintain the marine DO water quality criterion and the narrative nutrient criterion. The TMDLs to be implemented are those expressed on a mass per year basis, and the expression of the TMDL on a mass per day basis is for information purposes only.

Table 8 TMDL Components Expressed as an Annual Load for the Stevenson Creek Tidal Segment (WBID 1567).

Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)
	Wastewater (lbs/year)	NPDES Stormwater (percent reduction)			
$CBOD_5$	76,157[a]	85	9,314	Implicit	85,471
TN	33,509[a]	85	6,406	Implicit	39,915

a The Clearwater-Marshall St. AWWTP loads are based on long term average discharge conditions: discharge flow rate of 5 MGD, CBOD5 concentration of 5 mg/L, TN concentration of 2.2 mg/L, and DO concentration of 7 mg/L.

Table 9 TMDL Components Expressed as a Daily Load for the Stevenson Creek Tidal Segment (WBID 1567).

Parameter	WLA		LA (lbs/day)	MOS	TMDL (lbs/day)
	Wastewater (lbs/day)	NPDES Stormwater (percent reduction)			
$CBOD_5$	209[a]	85	26	Implicit	235
TN	92[a]	85	18	Implicit	110

a The Clearwater-Marshall St. AWWTP loads are based on long term average discharge conditions: discharge flow rate of 5 MGD, CBOD5 concentration of 5 mg/L, TN concentration of 2.2 mg/L, and DO concentration of 7 mg/L.

6.2 Load Allocation

The LAs were determined by reducing the estimated total nonpoint source loadings in conjunction with the loadings from the Clearwater-Marshall St. facility by the amount required to meet the assimilative capacity of the waterbody so that the water quality criteria for DO and nutrients are met. The assimilative capacity under the load reduction scenario selected was estimated to be an 85 percent reduction in the existing annual average 5-day CBOD ($CBOD_5$) and TN nonpoint source loads during the 1999 to 2006 period, which are presented in Section 4.3.2. The LA for $CBOD_5$ and TN are 9,314 lbs/year and 6,406 lbs/year, respectively. The loads are based on long term average conditions that were simulated in the tidal creek surface water model. Note that the $CBOD_u$ loads predicted by the HSPF model, were converted to a $CBOD_5$ load using a ratio of $CBOD_u$ to $CBOD_5$ of 2.84, as recommended in EPA guidance (USEPA 1997), in the absence of site specific data. A $CBOD_5$ result is more commonly used for establishing BOD limits, particularly for point source dischargers, and is consistent with the expression of the BOD limit as $CBOD_5$ in the existing Clearwater - Marshall St. AWWTP NPDES permit.

It should be noted that the LAs include loading from stormwater discharges regulated by the Department and the SWFWMD that are not part of the NPDES stormwater program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

The Clearwater-Marshall St. AWWTP WLA for $CBOD_5$ and TN are 76,157 lbs/year and 33,509 lbs/year, respectively. The loads are based on long term average discharge conditions that were simulated in the tidal creek surface water model. These loads are established in conjunction with the LA for nonpoint sources and the facility flow volumes reasonably expected to be discharged under existing conditions.

6.3.2 NPDES Stormwater Discharges

Pinellas County and Co- Permittees (FDOT District 7, City of Clearwater, City of Dunedin, and City of Largo) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000005) and areas within their jurisdiction contributing loads to the Stevenson Creek watershed may be responsible for a 85 percent reduction in current anthropogenic TN and $CBOD_5$ loadings. There are no Phase II MS4 permits identified in the watershed. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

As noted in Chapter 4, loadings from stormwater discharges permitted under the NPDES stormwater program (i.e. MS4 areas) are placed in the WLA, rather than the LA. The WLA is expressed as a percent reduction and was set at the same percent reduction needed for nonpoint sources to meet the LA. The actual load from NPDES permitted stormwater discharges are included in the LA, and the LA will be portioned between all parties responsible for nonpoint source loadings when the specific source information becomes available.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a MOS into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (Clean Water Act, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating pollutant loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings. In the TMDL development for the tidal reach of Stevenson Creek, an implicit MOS was accounted for by selecting a load reduction scenario that results in an overall average chlorophyll a value below the target of 8 ug/L, and which maintains a frequency of low DO similar to the frequency predicted under natural background loading conditions.

7.0 NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of these TMDLs by rule, the Department will determine the best course of action regarding their implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines that a BMAP is needed to support the implementation of these TMDLs, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDLs);*
- *Refined source identification;*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDLs;*
- *Timetables for implementation;*
- *Implementation funding mechanisms;*
- *An evaluation of future increases in pollutant loading due to population growth;*
- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

A multitude of assessment tools are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize sources of pollution. Based on work in the Lower St Johns River tributaries and the Hillsborough Basin, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work. In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

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